REMARKS/ARGUMENTS

Dear Examiner Duong:

Greetings!

First of all, Claim 10 is hereby withdrawn, with me reserving the right to include it in a future divisional/continuation/continuation-in-part patent application.

Many years ago, a certain professor of psychology that I once knew stated that 50% of the world's troubles were due to bad communications. I am not sure of the exact percentages, but I believe that he was correct at least on the order of magnitude. I believe that that is at least part of the problem here. The word "Automobile" literally means "Self-moving" (Auto=self, Mobile=moving). However, the word "Automobile" has taken on a very narrow and precise meaning, namely cars, (and in some cases pickup trucks and SUV's) to the exclusion of trains, airplanes, ships, farm tractors, motorcycles, and all other self-propelled vehicles. Likewise the term "Gas Producer" has taken on a very narrow and precise meaning as stated in the first paragraph on page 473 of "General Chemistry for Colleges", Third Edition, By B. Smith Hopkins (see attached copy)(also see "Marks Handbook"/"Mechanical Engineers Handbook", Fourth Edition, Lionel S. Marks, editor, pages 826-827, a copy of which is also attached).

Please note that in the producer gas process:

1. Heat is generated at or near the bottom of the fixed bed of coal/carbonaceous material via combustion. Hence the charge is heated internally, not externally. (Quite unlike 5,936,134 thus overcoming objection #4 to claim 11).
2. The hot gases rise/are drawn/are blown upwards, not downwards, with the carbon dioxide being reduced to carbon monoxide, and the volatiles being distilled out of the solid fuel charge (quite unlike 3,920,417 thus overcoming objection #2 to claims 1 and 11).

3. It distills out tar, ammonia, etc. which hence do not have to be (and cannot be) solvent extracted from some solid residue in the Gas Producer (quite unlike 5,936,134 thus overcoming objection #4 to claim 11).
4. It does not require a catalyst (quite unlike 5,936,134 thus overcoming objection #4 to claim 11).

Likewise on page 472 of "General Chemistry for Colleges" (as cited above)(see also pages 852-853 of "Marks Handbook" as cited above), it defines "Water Gas" as being a fuel gas manufactured from a solid fuel by first blowing air through a fixed bed of hot solid fuel causing combustion until the solid fuel is white hot (during which time the exhaust is vented off), then closing the vent and blowing steam through the hot fixed solid fuel bed, manufacturing an approximately equimolecular mixture of hydrogen and carbon monoxide which are drawn off and stored/used.

Hence the Water Gas Manufacturing Process is:

1. An intermittent continuous process (quite unlike 5,936,134 which is a batch process thus overcoming objection #4 to claim 11, and quite unlike 3,920,417 which is a steady continuous process thus overcoming objection #2 to claims 1 and 11).
2. The heat necessary for the process is supplied internally via combustion, <u>not externally</u> (quite unlike 5,936,134 which is performed in an externally heated reactor thus overcoming objection #4 to claim 11).
3. Is a high temperature process that distills out all of the volatiles (gases and liquids), and does not (and cannot) use solvent extraction to recover oil, etc. from the residue (quite unlike 5,936,134 thus overcoming objection #4 to claim 11).

Objection #3 is moot as I am withdrawing claim 10 as stated above.

Objection #5 to claim 2 is overcome by the fact that 4,057,398 in it's <u>only</u> independent claim, it's claim 1, covers <u>only</u> the use of "borates and naturally occurring boron-containing minerals", whereas my claim 2 lists <u>no</u> "borates" nor "naturally occurring boron-containing minerals", hence there is no overlap.

Objection #2 to claims 1 and 11 is overcome by the fact that Fernandes (3,920,417) does not use a Gas Producer-type layout (i.e. preheating and reducing zone combined and located together and generally above the oxidation zone)(see references above), nor a Water Gas Set-type layout where the preheating zone, the reducing zone, and the oxidization zone are all one and the same.

Objection #1 to claim 2 is overcome by the fact that the wording "the addition of monovalent alkali metal ....before combustion" is precise, clear, and definite to anyone "skilled in the art".

Objection #1 to claim 1 is overcome by the fact that claim 1 specifically refers and relates to " a gas producer or water gas set" both of which have very precise, clear, and definite meanings and methods of operation (see "Marks Handbook" cited above, pages 826-827, and 852-853 (see attached copies)), that are familiar to anyone "skilled in the art"(and unfortunately there are fewer and fewer of us).

Although claims 10 and 11 were not rejected by Objection #1, I will point out that claim 10 has already been withdrawn above, and claim 11 is precise, clear, and definite due to it's making specific reference to Gas Producers and Water Gas Sets similar to immediately above regarding claim 1.

I hope that this has clarified matters, and I respectfully request a grant of letters patent in a timely manner.

Have a nice summer.

Sincerely,

Scotlund Stivers

Scotlund Stivers

THE CHEMICAL ELEMENTS AND THEIR ATOMIC WEIGHTS
1941

	Symbol	Atomic Number	Atomic Weight		Symbol	Atomic Number	Atomic Weight
Actinium	Ac	89	......	Mercury	Hg	80	200.61
Aluminum	Al	13	26.97	Molybdenum	Mo	42	95.95
Antimony	Sb	51	121.76	Neodymium	Nd	60	144.27
Argon	A	18	39.944	Neon	Ne	10	20.183
Arsenic	As	33	74.91	Nickel	Ni	28	58.69
Barium	Ba	56	137.36	Nitrogen	N	7	14.008
Beryllium	Be	4	9.02	Osmium	Os	76	190.2
Bismuth	Bi	83	209.00	Oxygen	O	8	16.0000
Boron	B	5	10.82	Palladium	Pd	46	106.7
Bromine	Br	35	79.916	Phosphorus	P	15	30.98
Cadmium	Cd	48	112.41	Platinum	Pt	78	195.23
Calcium	Ca	20	40.08	Polonium	Po	84	......
Carbon	C	6	12.01	Potassium	K	19	39.096
Cerium	Ce	58	140.13	Praseodymium	Pr	59	140.92
Cesium	Cs	55	132.91	Protoactinium	Pa	91	231.
Chlorine	Cl	17	35.457	Radium	Ra	88	226.05
Chromium	Cr	24	52.01	Radon	Rn	86	222.
Cobalt	Co	27	58.94	Rhenium	Re	75	186.31
Columbium	Cb	41	92.91	Rhodium	Rh	45	102.91
[illegible]	Cu	29	63.57	Rubidium	Rb	37	85.48
[illegible]	Dy	66	162.46	Ruthenium	Ru	44	101.7
[illegible]	Er	68	167.2	Samarium	Sm	62	150.43
[illegible]	Eu	63	152.0	Scandium	Sc	21	45.10
[illegible]	F	9	19.00	Selenium	Se	34	78.96
[illegible]	Gd	64	156.9	Silicon	Si	14	28.06
[illegible]	Ga	31	69.72	Silver	Ag	47	107.880
[illegible]	Ge	32	72.60	Sodium	Na	11	22.997
Gold	Au	79	197.2	Strontium	Sr	38	87.63
Hafnium	Hf	72	178.6	Sulfur	S	16	32.06
[illegible]	He	2	4.003	Tantalum	Ta	73	180.88
Holmium	Ho	67	164.94	Tellurium	Te	52	127.61
Hydrogen	H	1	1.008	Terbium	Tb	65	159.2
Illinium	Il	61		Thallium	Tl	81	204.39
Indium	In	49	114.76	Thorium	Th	90	232.12
Iodine	I	53	126.92	Thulium	Tm	69	169.4
Iridium	Ir	77	193.1	Tin	Sn	50	118.70
Iron	Fe	26	55.85	Titanium	Ti	22	47.90
Krypton	Kr	36	83.7	Tungsten	W	74	183.92
Lanthanum	La	57	138.92	Uranium	U	92	238.07
Lead	Pb	82	207.21	Vanadium	V	23	50.95
Lithium	Li	3	6.940	Xenon	Xe	54	131.3
Lutecium	Lu	71	174.99	Ytterbium	Yb	70	173.04
Magnesium	Mg	12	24.32	Yttrium	Y	39	88.92
Manganese	Mn	25	54.93	Zinc	Zn	30	65.38
Masurium	Ma	43		Zirconium	Zr	40	91.22

GENERAL CHEMISTRY
FOR COLLEGES

Third Edition

BY

B SMITH HOPKINS

PROFESSOR, EMERITUS, OF INORGANIC CHEMISTRY
UNIVERSITY OF ILLINOIS

D. C. HEATH AND COMPANY

BOSTON NEW YORK CHICAGO
ATLANTA SAN FRANCISCO DALLAS
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General Chemistry for Colleges

4 c 2

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Water gas. A widely used variety of gas is manufactured by the method of passing steam through a mass of coke which has been heated to a white heat. Under these conditions a reaction takes place: $C + H_2O \rightarrow CO + H_2$, producing a gas mixture which is called **water gas.** This reaction is highly endothermic and as a result the temperature of the coke falls rapidly. When it has cooled to a temperature at which the reaction no longer proceeds readily, the steam is turned off and a blast of air admitted. This burns some of the coke, liberating heat and raising the temperature of the coke again to white heat. During this heating process the main product is carbon dioxide, which is allowed to escape. By alternately blowing air and steam through the mass of coke an intermittent supply of water gas is obtained, at a cost of manufacture considerably less than for coal gas.

Water gas is mainly carbon monoxide and hydrogen, both of which burn with the liberation of much heat but little light. On this account water gas is useful for cooking purposes but it has little value for illumination unless it is used with a Welsbach burner (p. 468). To correct this situation water gas is usually enriched by adding some petroleum oil from which a good proportion of illuminants is obtainable. The oil is sprayed into a carburetor, a retort filled with a hot checkerwork of brick, in which the oil is vaporized, then into a superheater which contains a network of brick kept at a somewhat higher temperature. Here the oil vapors are cracked, the operation being so regulated as to introduce as large a proportion as possible of the unsaturated hydrocarbons. The cracking process deposits some carbon, and some tar also is produced. This is removed by scrubbing the gas as it passes out toward the gas holder for storage.

Gas produced in this manner is moderate in cost and satisfactory for both heating and lighting purposes, but its high carbon monoxide content makes it extremely poisonous. As a result its use in the home requires constant vigilance, since a slight leak in the gas stove or pipes is dangerous on account of the cumulative effect of carbon monoxide poisoning. Fortunately the enriching of water gas gives it a characteristic odor which makes the detection of a leak a much simpler problem than would be possible if the simple water gas were used.

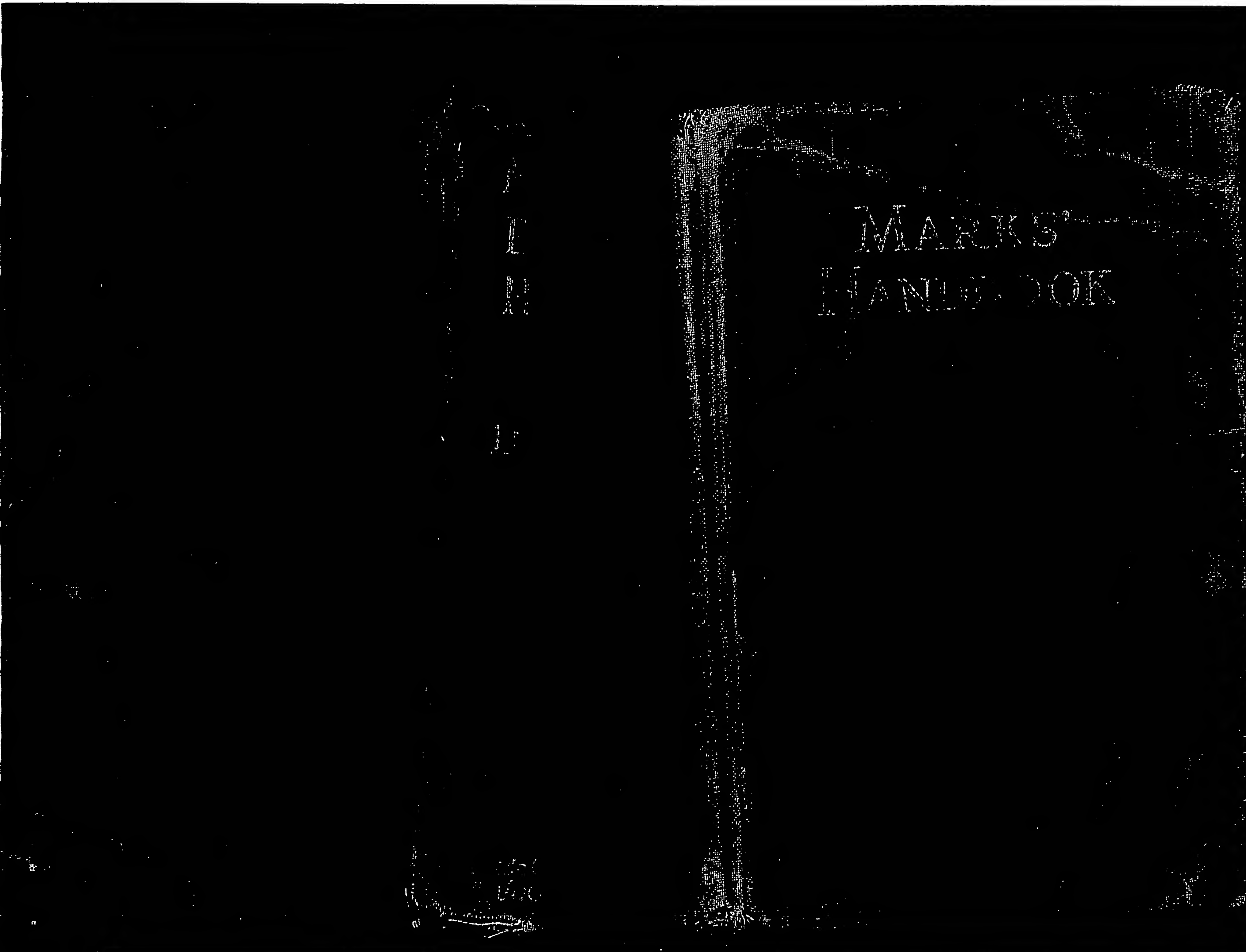
In addition to its use as a gaseous fuel, water gas is finding an increasing use as a source of hydrogen (p. 97) and as a fuel in aeronautics. For the latter purpose the gas, which is only slightly heavier than air, is stored in a special compartment from which it is supplied to the engines. The advantage in its use comes from the fact that the buoyancy of the airship is not materially changed by the burning of this variety of fuel.

General Chemistry for Colleges

Producer gas. A cheap gaseous fuel is made for many industries by a method which may be regarded as a combination of the processes of manufacturing coal gas and water gas. In this process the lower layers of a deep bed of coal are heated to a high temperature by a blast of air, producing CO_2. As this gas passes upward through the upper layers it is reduced to CO and at the same time some of the volatile gases from the coal are distilled out. Usually some steam is added to the air blast, which results in the production of some water gas. The amount of steam is so regulated that the heat absorbed in the formation of water gas is less than that liberated in the production of carbon dioxide; consequently the process is continuous. This type of gas is called **producer gas** or semiwater gas. Its combustible components are carbon monoxide, hydrogen, and methane, but it always contains some carbon dioxide and large proportions of nitrogen from the air blast (see Table 34). If desired, the gas may be purified by removing dust, tar, and ammonia, but this is not always necessary. The gas may be used either for heating a furnace or in internal combustion engines for generating power.

Blast-furnace gas. In the reduction of iron ore an excess of carbon is mixed with the iron oxides and the whole mass is heated to a white heat by a strong blast of air. (See p. 701.) Usually the ore contains moisture and these conditions are very similar to those which are found in the generator of a producer-gas plant. As a result the gases which escape from the blast furnace contain much carbon monoxide and some hydrogen. Since the main object in this process is the production of iron, the gases are always considered as a by-product. They contain a larger proportion of noncombustible components (see Table 34) than producer gas, but they are usable as a rather low-grade gaseous fuel. Formerly these were not utilized, but in modern practice they are used to generate power in a battery of gas engines.

Flame. It is a well-known fact that when we burn solids like charcoal and coke which have been heated until all gases have been expelled, there is no flame. On the other hand a flame always is seen when we burn a solid like wood or coal from which combustible gases may readily be expelled by heat. From such a study it has been concluded that a flame is the phenomenon which accompanies the union of two gases. One of these gases is almost invariably the oxygen of the air, while the other is called a combustible gas, by which we mean that it unites readily with oxygen. When wood burns, the heat of the reaction expels combustible gases from adjacent portions of the wood,


MARKS'

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EDITED BY

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Harvard University

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Mark's Mechanical Engineers Handbook

GAS PRODUCERS AND GAS CLEANING

BY

B. J. C. VAN DER HOEVEN

GAS PRODUCERS

In gas producers, solid fuels are converted into gaseous fuel. By continuous partial oxidation of incandescent solid fuel, using air, with or without added steam, a gas is made containing CO and H_2 as principal combustible components mixed with an appreciable volume of inert gases such as CO_2 and N_2 and smaller amounts of CH_4, illuminants, etc. For **general theory**, see p. 372.

Producer gas is used for heating industrial furnaces of steel and glass works, coke and gas plants, etc.; when properly cleaned it can be used in gas engines.

The gas producer is built as a brick shaft or a steel shell, operated by hand or mechanically, using bituminous coal, anthracite, coke, wood, or combustible waste materials as fuel. Best efficiency and uniformity are obtained with lowest operating cost in mechanical producers. Such producers have mechanical charging devices, continuous ash-removal, fuel-bed stirring devices, etc. One man can supervise the operation of several machines. Typical examples of mechanical producers with coke and anthracite as fuel are Koppers-Kerpely, U.G.I., Koller, and Galusha; with bituminous coal, Wellman, Morgan, Wood, and Chapman. Many producers lack some of the mechanical features and consequently have less favorable working characteristics.

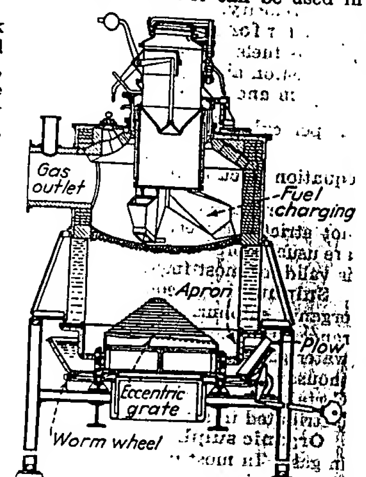

FIG. 1.—Koppers Producer.

Coke and Anthracite Producers

The **Kerpely**-type producer (Fig. 1) is a vertical cylindrical steel shell ⅜ in. thick, 7 to 10 ft i.d., surrounded over part of its height with a pressure water jacket connected to a steam drum in which circulation of water is maintained and low-pressure steam (5 to 15 lb per sq in.) is made. The upper part of the shell as well as its top is lined with 9 to 13.5 in. of firebrick backed with insulating material; the shell has a firebrick-lined gas offtake. The shell is supported on columns. The ash and fuel bed inside the producer are carried on a cast-iron grate customarily of stepped cone shape and provided with the necessary slots to admit the air and steam blast. For ease of removal this grate is often built up of several sections. It is set up on a platform which, together with its sloping sides, forms a pan, serving as a container for water, which seals off the shell. For agitation of the fuel bed as well as removal of ashes, the center of the grate is set 4 in. off the center of the pan, and the pan can be rotated by a gear drive at a variable rate of

up to one revolution per hour. The height of the water jacket varies from 6 to 12 ft, depending on the height of fuel bed carried and the amount of low-pressure steam desired. Generally the bottom of the jacket is level with the top of the grate and the top of the jacket with the top of the fuel bed; this prevents wall clinker. There is a space of 2 to 3 ft between the top of the fuel bed and the gas offtake. At the lower edge of the shell is attached a cylindrical, heavy cast-steel apron, 2 to 3 ft deep, which dips in the water; the eccentric grate and apron together serve as a breaker for large lumps of clinker. Separate clinker breaker bars are attached to the apron. A stationary plow inserted radially along the inside of the pan stops the movement of the ashes going around with the producer pan and causes them to build up ahead of it and drop over the sides of the pan for removal. The charging mechanism used is either ring feed or "pants-leg" feed; both maintain constant height of fuel bed by supply from a fuel magazine on top of the producer. In the former the magazine is stationary and ring-shaped, set up on the periphery of the shell, the gas offtake being in the center. In the latter the magazine is central and feeds fuel through three spouts onto the bed, the magazine, including the spouts, revolving at a rate of six revolutions per hour. Older types of producer have a hand-feed mechanism with charging bells.

Several observation holes on top of the producer permit inspection of the condition of the fire. Seals to hold blast and top air pressure are provided in the blast pit under the grate and at the edge of the revolving top respectively. If high pressures are desired the pan is made deeper and a special ash-extracting device is used to move the ash over the pan sides. The depth of the pan seal is usually 15 in., top seals 12 in., blast seals 30 in. For driving the pan a 3 hp motor, for the top a 1 hp motor are required.

The total height of this type producer from blast seal to top is 19 to 20 ft, including the mechanical magazine feed, 11 to 12 ft if hand feed is used. The free area required for a shell of 10 ft. i.d. is 20 × 20 ft, total weight of producer plus auxiliaries in operating condition is 80 tons on the grate foundation, 90 tons on the shell foundation, total 170 tons.

The gas leaving the producer is usually passed through a waste-heat boiler provided with steam drum, dust pockets, soot blower, etc., and leaves it to be scrubbed by water in a countercurrent hurdle-filled tower.

The gas offtake of a 10 ft producer is 36 in. i.d. for the hot gas, 30 in. for the gas after cooler. Large water-sealed mushroom valves are used to shut off producers from the line, and bleeders for each individual producer are available.

The air for the producer blast is supplied by blowers, for a 10 ft producer a blower of 5,500 cfm capacity against a 24 in. w.g. head is required, driven by a motor of about 40 hp. The steam required for the blast varies around 0.01 lb per cu ft of air used and is usually amply covered by the low-pressure steam made in the producer jacket.

The **U.G.I.** producer is usually of ring-feed type, and its general features are the same as described above.

The **Koller** producer has central stationary magazine feed, full-height pressure jacket, central blast tuyère, revolving water-sealed grate.

The **Galusha** producer has a stationary magazine, located above the producer top and feeding fuel down through several pipes to the fuel bed. The producer top is cooled by the blast air, and the latter picks up water vapor by passing over the top of the jacket water. The revolving eccentric grate consisting of spaced steel disks is set up on a flat pan, the ash drops over

Mark's Mechanical Engineers Handbook

and gasification is carried out by aid of catalysts and with or without elevation of pressure. See Fischer-Tropsch process, p. 818.

GAS MAKING

Water gas, or **blue gas** (see p. 372), consists chiefly of carbon monoxide and hydrogen, formed by the action of steam upon hot coke or coal. Some carbon dioxide is present, resulting from the primary reactions, and a small amount of methane, formed principally by a secondary reaction between carbon monoxide and hydrogen. **Carburetted water gas** contains, in addition, the hydrocarbon gases resulting from the cracking of enriching oils. Its composition varies with the quality of oil and fuel used and with the operating cycle in the manufacturing process. Typical percentage volumetric compositions are as follows:

Gas	CO_2	O_2	Illuminants	CO	H_2	CH_4	N_2	Sp gr	Btu per cu ft
Blue gas	5.0	0.6	...	38.0	48.0	1.2	7.2	0.56	290
Carburetted water gas	4.2	0.3	8.8	33.5	37.0	12.5	3.7	0.64	530

Coke, lump bituminous coal, and occasionally anthracite are used as **fuels** in the generator, coke being the most common. Bituminous coal is used when the price is low enough to overcome the lower capacity when using this fuel. The fine sizes, from both coke and coal, are first removed, bituminous being generally 3 × 6 in. lump. Mixtures of coal and coke have been found advantageous.

Table 4. Typical Analyses of Fuels for Manufacture of Blue Gas[a]

Kind of fuel	Moisture "as received"	Analysis on dry basis, percent: Volatile matter	Fixed carbon	Ash	Sulphur	High heat value, Btu per lb	Ash fusion point, deg F	Size of fuel, in.
Anthracite, broken	3.55	5.27	84.90	9.83	0.78	13,561	2800	3 7/16 to 4 7/16
Water-gas coke (average of 323 from by-product ovens)	3.56	1.93	89.76	8.31	0.60	......	>2300	2
Horizontal- and inclined- retort coke	10.09	1.91	87.92	10.17	0.73	12,746		
By-product oven coke	3.13	1.99	89.17	8.84	0.63	13,081		
Water-gas coke	1.67	2.21	87.32	10.47	1.11	13,004	2768	
Spokane gas-house coke	1.30	8.3	70.3	21.3	......	11,150		
Denver gas-house coke	......	2.88	79.58	17.54	0.62	11,899		
Boone-Chilton coal	1.82	36.48	58.73	4.79	0.56	14,380	2825	
Fairmont gas coal	1.06	34.67	58.16	7.17	1.00	......	......	3–6
Elkhorn gas coal	1.94	37.77	59.11	3.12	0.54	14,750	......	3–6
Perry County, Ill	7.77	36.72	53.45	9.83	1.40	12,816		
Whatcom County, Wash	8.01	43.44	37.23	19.33	0.35	10,760	......	Washed pea-size
Portland lamp-black briquet	3.40	9.0	90.7	0.3	......	15,100		

[a] J. J. Morgan. "Manufactured Gas," Columbia University.

The blue-gas process consists of alternate **blows** (with air) and **runs** (with steam) in a vertical cylindrical generator with mechanical (rotating) grate; the blow gases are passed to a waste-heat boiler, often mixing with more air to burn the CO content.

Typical **results in the manufacture of uncarburetted blue gas** are as follows (Morgan, "Manufactured Gas"):

Material per Mcf: coke as charged, 36.2 lb; air for blast, 2,230 cu ft; steam used, 51.9 lb; moisture in coke, 1.5 lb; steam decomposed, 23.85 lb; steam undecomposed, 29.55 lb.

Analysis of blast gases entering the waste-heat boiler, percent by volume: carbon dioxide, 19.9; oxygen, 1.1; nitrogen, 79.0. Temperature of blue and blast gases: entering the waste-heat boiler, 1300; leaving the waste-heat boiler, 550 F.

The additional boiler fuel required in plant operation (above waste heat from gases) is 6 to 10 lb per Mcf gas made.

For **carburetted water gas** the apparatus used consists of (1) the generator (7 to 12 ft inside diam) containing the fuel, alternately blown with air and steam; (2) the carburetter, usually containing heated checker brick over which oil is sprayed for enrichment; (3) the superheater, containing heated checker brick for cracking and fixing the vapors derived from the oil; and (4) waste-heat boilers for recovering heat from the blow gases, as air is passed through the generator, and sometimes also from the make gas, when steam is passed. The waste-heat boilers, when used on the **make run,** are on the **up-run** step only, the **down-run** and the **back-run** steps in the cycle, if used, passing their gas direct to the scrubbing apparatus.

Average temperatures in the manufacture of carburetted water gas are: blow gases from the generator through superheater, 1300 to 1400; make gases from the superheater, 1200 to 1350; down-run gas from the generator, 350 to 450; gases from the waste-heat boiler, 420 to 550 F.

Average capacity of 9-ft set: gas made per hour (550 Btu), 100,000 to 150,000 cu ft; fuel gasified per hour per square foot of grate, 80 to 90 lb; depth of fuel bed, 4 to 7 ft; blast pressure, 25 to 35 in. water; oil efficiency, 90,000 to 110,000 Btu per gal; average tar yield, 20 to 26 percent of oil used.

Average quantities of materials required per Mcf of 550 Btu gas: generator fuel, 15 to 30 lb; boiler fuel, without waste-heat boiler, 8 to 14 lb; with waste-heat boiler, 4 to 10 lb; air with coke or anthracite, 1,400 to 1,800 cu ft at 60 F and 30 in., with bituminous coal, 1,000 to 1,400; total steam used in generator 25 to 35 lb; oil, 2.8 to 3.8 gal; percent of total heat in fuel, oil, and steam recovered in heat value of the gas alone, 60 to 66.

Operating Cycles. For **blue gas** the average cycle is: **air blow,** 2 to 4 min, passing the blast gases to a waste-heat boiler at 1300 to 1500 F after adding some air in a combustion chamber; **steam run,** 3 to 6 min, splitting into **up run** and **down run** if desired for improving fuel-bed conditions and thermal efficiency. Blue gas is also usually passed through a waste-heat boiler to recover the sensible heat of the gas and of the undecomposed steam.

The average operating cycle for **carburetted water gas,** regular system, is **air blow,** 2 to 4 min, passing the blast gases, with secondary air, through the carburetter and superheater and thence to the waste-heat boiler; **steam run,** 3 to 6 min (splitting into up and down runs if desired), with or without use of waste-heat boiler; **air-blow purge,** fraction of a minute, to recover gas left in the apparatus. If any down run is used, a few seconds of up run must always follow it, preceding the blow.

In the **down-run Chrisman cycle,** part of the run is made down and the gas is sent direct to the wash box and scrubbers, by-passing the carburetter

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